SECTION 4 - TRANSPORTATION RATE ANALYSIS

DEVELOPMENT OF THE RATE SAMPLE

To form the basis of the transportation rate analysis, a sample of aggregated movements was selected from a subset of the 1992 Waterborne Commerce detail records database. As was discussed earlier, in Section 2, at the time this analysis was conducted, the most recent database completed by WCSC was for the year 1993. However, in 1993 the Mississippi River basin had experienced major flooding severely affecting inland navigation over several months. Because of this, the 1992 WCSC database was used since this represented a more typical year of commerce on the inland waterway system. Transportation rates were developed for this sample of movements. This process was accomplished as follows.

The records in the WCSC database represented individual barge-level movements that traveled any portion of the GIWW -Mississippi River to Sabine, GIWW - Morgan City to Port Allen Alternate Route, Atchafalaya River or the Innerharbor Navigation Canal waterways. In addition to tonnage and origin/destination information, these records also include a 5-digit commodity code and a waterway routing indicator (alt code) for movements where alternative routings are applicable. Records with the same 5-digit commodity code, origin port, destination port and alt code were aggregated to produce annual port-level tonnage flows representing 8,081 records and 81.1 million tons. All subsequent processing was based on these aggregated annual flows. The file was then aggregated again into "cells". These "cells" consisted of movements with a common origin PE, destination PE, alt code and 10-group commodity code, with its level of tonnage equal to the sum of those movements. A PE (Port Equivalent) code is defined by ranges of WCSC port-dock codes and represents a waterway section.

At the outset, it was thought possible that a sample could be developed that would provide cell-level coverage of approximately 90 - 95 percent of the total system tonnage. To do this 950 of the largest "cells" (by tonnage) were selected from the aggregated file. Summing the tonnage in these 950 "cells" produced 74,619,000 million tons, which represented 92 percent of the total system tonnage of 81,105,000 tons.

Next, within each "cell", individual movements were assigned a weight equal to its own tons divided by the total tonnage in the "cell". These percentages were then transformed into cumulative percentages and multiplied by 100 to produce an integer between 1 and 100 for each movement. Next, using a random number generator, a number between 1 and 100 was assigned to each "cell".

The first movement within each "cell" whose integer was greater than or equal to this random number was selected for the sample. The effect of this procedure was to select a single movement from each "cell" with the probability of selection for a given movement equal to that movement's "cell" tonnage proportion. The final product was a sample of 950 movements with a total of 35,410,000 tons, 44 percent of the total system tonnage. Table 4 - 1 displays the 1992 rate sample tonnage as a percent of 1992 system tonnage by commodity group.

TRANSPORTATION RATE ANALYSIS

The transportation rate analysis was conducted by the Tennessee Valley Authority (TVA) under

Table 4 - 1

1992 Rate Sample Tonnage as a Percent of 1992 System Tonnage

Commodity Group	Sample Tons as a percent of System Tons	Sample Cells as a percent of System Cells	Sample Cell Tonnage as a percent of System Tonnage
Farm Products	29%	22%	81%
Metallic Ores and Products	45%	19%	77%
Coal	81%	51%	99%
Crude Petroleum	50%	58%	98%
Nonmettalic Minerals	45%	34%	91%
Forest Products and Pulp	70%	16%	77%
Industrial Chemicals	39%	39%	90%
Agricultural Chemicals	21%	14%	63%
Petroleum Products	33%	43%	94%
All Others	38%	10%	64%
Total	44%	33%	92%

contract with the New Orleans District. The objective of the study was to calculate line-haul transportation rates and supplemental costs for a sampling of 950 dock-to dock movements taken from the 1992 waterborne traffic base.

For each sample movement, a calculation of freight rates was made by a system waterway route, by one or more land routes utilizing an alternate mode of transportation (rail or truck) or by a non – system waterway route (Tennessee – Tombigbee Waterway). Total origin to destination shipping costs were calculated, including loading and unloading costs at origin and destination. The costs of subsequent overland movements and intermodal transfer costs at origin and destination were also calculated. Computations reflect those charges that were in effect during the fourth quarter of 1996. The following paragraphs detail the study's guidelines, methods of research and supporting assumptions.

ASSUMPTIONS

Actual shipment costs and supporting information were obtained from shipper, receivers, carriers, and riverport terminals wherever possible. In the absence of specific shipper/receiver information, it was assumed that the river origin and destination were the originating and terminating points for both the river route and alternate mode of transportation.

It was assumed that commodities loaded or unloaded to or from barges could also be loaded or unloaded to or from rail cars or trucks.

It was assumed that the alternate modes of transportation would have the physical capacity to accommodate the tonnages involved for each commodity movement, except that truck transportation was not considered to be a viable option for shipments involving tonnage of 100,000 tons or more.

It was assumed that for movements involving tonnages of less than 100,000 tons, shippers or receivers not served by rail would utilize truck transportation from or to the nearest railhead. It was further assumed that facilities would be available at the rail location to accommodate the transfer. For movements involving tonnages of 100,000 tons or more, it was assumed that rail facilities would be constructed by the carrier, shipper, or receiver. It was assumed that any construction costs incurred by the shipper or receiver would be assigned to the cost of production, rather than to the cost of transportation. While it is possible that construction costs incurred by carriers would be passed on to shippers or receivers in the form of higher rates, these costs were considered to be beyond the scope of this study.

METHODS AND PROCEDURES

As a result of transportation deregulation, it is virtually impossible to determine with absolute precision the exact rate charged by a carrier on a large-tonnage movement. Barge rates are a matter of negotiation between shipper and carrier and are not published in printed tariff form. Each carrier's rates are based on individual costs and will vary from one barge line to another.

Contract rates are prevalent in the rail and trucking industries and are not public knowledge. Rates are published in tariff form on bulk commodities; however it is difficult to determine those movements that are rated on a tariff basis as compared to those movements that are rated on a contractual basis.

Rates provided by carriers, shippers, receivers or riverport terminals were used wherever possible. All other rates were obtained from published sources or were constructed by TVA, depending on the mode of transportation or tonnages involved.

Barge Rates

With the exception of actual rates obtained from shippers, carriers, or riverport terminals, barge rates were calculated using a computerized barge costing model. The model, which was obtained from another government agency and modified by TVA, was programmed to include 1996 fixed and variable costs information obtained from the towing industry.

The costing model contains three modules - a one-way general towing service module, a round-trip dedicated towing service module and a round-trip general towing service module.. The one-way general service module calculates rates by simulating the use of general towing service conditions between origin and destination, including the potential for a loaded return.

The dedicated service module calculates costs based on a loaded outbound movement and the return movement of empty barges to the origin dock. This includes the use of the same towboat for the loaded movement from origin to destination and the return of the empty barge(s) from destination back to origin.

The round-trip general towing service module is similar the to one-way, except that it provides for the return of empty barges to the point of origin. It does not require that the empty barges be returned with the use of the same towboat.

The three modules require various inputs, but among the more important are, towboat sizes (horsepower); barge types; shipment weights; and empty return ratios.

Barge rates on dry commodities were calculated using the general towing service costing module. Inputs based on information obtained from carriers and the Corps of Engineers' Lock Performance Monitoring System (LPMS) database were used in the module to simulate the average towboat size (horsepower) and corresponding tow size (barges) for each segment of the inland waterway system. Other inputs included barge types, waterway speeds and horsepower ratios.

Empty return ratios for dry commodity movements were generally calculated at 70 percent; however movements with both origin or destination on the Intracoastal Waterway east of Houston or origins or destinations on the Lower Mississippi south of Baton Rouge were calculated on a round-trip basis.

Barge rates for crude petroleum, asphalt, heavy fuel oils, and light petroleum products were calculated through the use of the dedicated service round-trip costing module. Barge rates for sodium hydroxide, vegetable oils, lubricating oils, liquid chemicals, and molasses were calculated through the use of the general service round-trip costing module.

Rail Rates

As in the case of barge, reported rail rates were used in every case for which they are available. However, in the face of incomplete information, most movements required the calculation of probable railroad rates. For grain and feed ingredients, two methods were used. First, the appropriate tariff rate is identified. Next, the Rebee Rail Costing Model was used to generate an estimate of rail movement cost. This cost was then inflated to reflect rail carrier market power in order to produce a final estimate of the most likely rail rate. For those cases in which the published tariff was lower than the estimated rate, the tariff rate was selected for use. Conversely, when the estimated rate was lower than the tariff rate, it was the estimated rate, which was retained for inclusion in the surface and alternative rate analysis.

Rates for all other commodities were calculated based on the Rebee cost estimates plus an appropriate mark-up. Market-up factors and shipment characteristics were determined through a variety of means, with shipper information being the preferred source.

Truck Rates

Actual truck rates were used wherever possible. All other rates were estimated based on published motor carrier tariffs or regional rate quotations from truck brokers and contract motor carriers.

Handling Charges

Handling charges between modes of transportation were estimated on the basis of information obtained from shippers, receivers, and terminal operators. Handling charges for transfer of commodities from or to ocean vessels were estimated on the basis of information obtained from ocean ports or stevedoring companies. In general, it was assumed that movements of bulk products, (e.g., grain) would be handled through elevator or storage facilities at both origin and destination.

Loading and Unloading Costs

Loading and unloading costs are not normally documented by shippers and receivers. Costs will vary from company to company and are oftentimes considered as part of the cost of production. A number of sources were utilized in obtaining loading and unloading costs, but for the most part reliance was placed on information obtained from shippers and receivers.

Attachment 1 of the appendix summarizes the results of this study. The attachment consist of the commodity, tons, original water route cost, land route cost and Tenn-Tom route cost for each of the 950 sample movements.

<u>EXPANDING THE RATE SAMPLE TO THE POPULATION</u>

ASSIGNMENT PROCESS

As was mentioned previously, the sample movements evaluated by TVA represented 1992 WCSC data. The next objective was to match transportation rates from the 950 sampled movements to the population representing 8,081 movements for the entire waterway system. To accomplish this task, it was necessary to match sampled records to the population at several levels of aggregation.

In the first level matching, records in the sample rated by TVA were matched to the population of records on the basis of common origin port, origin dock, destination port, destination dock, Altcodes and 5-digit commodity code. This essentially represented a direct record to record match from the sample to the population. Therefore, this initial matching assigned costs to 950 movements (12 percent of the total population of movements) which totaled to 35,409,643 tons (44 percent of the total system tons). Whenever a match was identified total transportation costs for the original water route, alternative land route (Rail was always less costly than truck, therefore, matching truck costs was considered unnecessary.), and alternative water route (Tenn-Tom) were assigned to the movement in the population.

In order to assign costs to those movements not initially matched, several more levels of matching needed to be performed. The second matching was based on common origin PE, destination PE, Altcodes and 10-group commodity between the sample and the movements not matched in the first level. This is the "cell" level of aggregation described earlier when development of the sample was discussed, where each of the records in the sample represented a unique "cell". As a result, those movements that were not matched in the first level were assigned the total cost, for the various means of transportation, if its "cell" matched one in the sample. After this second level of matching, 5,159 records (64 percent of the system movements) representing 73,846,086 tons (91 percent of the total tonnage) were assigned costs.

The third level of matching was based on common waterway segment origin and destination (the 2-digit level of the 4-digit origin and destination PE codes), Altcodes and 10-group commodity code. At this level of matching, as well as the following ones, the weighted average costs per mile for the various means of transportation were calculated, grouped as described for this level of matching. Weighted average cost per mile was used because from level 3 on, the potential for substantial mileage variation existed between the sample movement and the population movement matched to it. Since transportation costs are very much a function of distance, it was viewed as necessary to assign a mileage sensitive cost. When a sample movement was matched to an unassigned movement in the population, the cost per ton mile for the sample movement was multiplied by the mileage of the unassigned movement. This product was the cost per ton assigned to the movement. For example, the weighted average cost per mile of an original water rate from a sample movement was multiplied by the water mileage of the unassigned movement. This method works well for assigning original water cost per ton estimates to unassigned population movements since in the population file, water mileage estimates are already included in the WCSC file. However, when assigning alternate land and alternate water cost per ton estimates, the appropriate alternate land mileage and alternate water mileage in the population file had to be calculated externally.

To estimate alternate land mileages and alternate water mileages in the file, a regression analysis was performed using data from the TVA rate sample. The primary objective of regression analysis is to predict the value of one variable (the dependent variable) given that the value of an associated variable (the independent variable) is known. The regression equation is the algebraic formula by which the predicted value of the dependent variable is determined.

Along with transportation costs for each of the sampled movements, TVA also provided estimates on original water mileage, alternate land mileage, and alternate water mileage. By running a regression analysis, with original water mileage as the independent variable and land mileage as the dependent variable, the resulting regression equation could be used to predict a land mileage based on the original water mileage estimate in the population file. The regression analysis, performed on the sample movements, was done on the 10-commodity code classification scheme. As a result, each of the 10 commodity codes has an individual regression equation.

The regression equations used to predict primary land mileage estimates, in the population file, are provided in table 4 - 2. Also included, are the coefficient's of determination (R-squared) for each of the 10 equations. This coefficient indicates the proportion of the variance in the dependent variable (land mileage), explained by knowledge of the independent variable (original water mileage). Tests of significance indicate that there is a statistically significant relationship between these two variables.

In order to estimate alternate water mileage for the population movements, another regression analysis was performed on the rate sample using the land mileage as the independent variable and the alternate water mileage as the dependent variable. This formulation for estimating the alternate water mileage was selected from a variety of other investigated specifications, because it produced the greatest degree of explanatory power. (In the sample, only movements with an alternate water mileage were included in the analysis.) The resulting regression equations were then used to predict the alternate water mileage based on the alternate land mileage already calculated from the previous regression analysis. (For the population movements, an alternate water mileage was calculated for only those movements where the Tenn-Tom Waterway was considered a reasonable alternate route.)

As before, the regression analysis was performed for each of the 10 commodity groups, however for crude petroleum, forest products, and the all other commodity group, there were not enough movements in the rate sample to perform a meaningful analysis. Therefore, the decision was made to perform the regression analysis on all the sample movements with an alternate water mileage, disregarding the commodity group distinction. This single regression equation was used to estimate alternate water miles for these three commodity groups. The resulting eight different regression equations along with their coefficients of determination are also displayed in table 4 - 2. As with the previous regression equations, test of significance revealed a true relationship between the two variables.

With the above mileage estimates, the alternate land and alternate water cost per ton calculations were performed in the same manner as the original water costs per ton. After this third level of matching, 6,864 movements (85 percent of the total population of movements, representing 78,266,270 tons (97 percent of the total tonnage, were assigned costs.

The fourth level of matching was based on common waterway segment destination (the 2-digit level of the 4-digit PE code), and 10-group commodity code for. As before, this procedure assigned a weighted average cost per mile, for the various means of transportation, to the population movements when a sample movement matched an unassigned population movement. This cost per mile was then multiplied by the appropriate mileage figure to produce a cost per ton estimate. After this fourth level of matching, 7,831 movements (97 percent of the total population of movements), representing 80,530,381 tons (99 percent of the total tonnage), were assigned costs.

Table 4 - 2

Regression Equations Used to Predict
Alternate Land Miles and Alternate Water Miles

Commodity	Alternate Land Miles	R-Squared	Alternate Water Miles	R-Squared
Farm Products	14.0186 + .8158 x Original Water Miles	0.81	731.6215 + .5978 x Land Miles	0.83
Metallic Ores	86.0145 + .6906 x Original Water Miles	0.88	198.4467 + 1.1891 x Land Miles	0.88
Coal	284.1632 + .4177 x Original Water Miles	0.75	37.4470 + 1.1455 x Land Miles	0.79
Crude Petroleum	-4.9531 + .9219 x Original Water Miles	0.91	361.0365 + .9814 x Land Miles	0.81
Non-Metallic Minerals	0.0000 + .8509 x Original Water Miles	0.89	381.0805 + 0.9055 x Land Miles	0.90
Forest Products	131.5304 + .4377 x Original Water Miles	0.94	361.0365 + .9814 x Land Miles	0.81
Industrial Chemicals	66.6536 + .7267 x Original Water Miles	0.95	423.8506 + .9771 x Land Miles	0.82
Agricultural Chemicals	162.3927 + .8426 x Original Water Miles	0.82	131.8454 + .8519 x Land Miles	0.78
Petroleum Products	108.2428 + .6970 x Original Water Miles	0.92	209.3971 + 1.2020 x Land Miles	0.86
All Others	-71.3814 + .7639 x Original Water Miles	0.98	361.0365 + .9814 x Land Miles	0.81

In the fifth and last level of matching, those records that were still unassigned were matched based only on the 10-group commodity code. As with the third and fourth level of matching, this assignment was accomplished using the product of the costs per mile from the sample movements, now grouped as described in this fifth level of matching, and the appropriate mileage of the movement to be assigned a cost. With this last level of matching, all 8,081 movements in the population file were assigned an original water cost per ton, an alternate land cost per ton, and an alternate water cost per ton.

SUMMARY OF RESULTS

For each of the movements in the population file, an estimate of the difference between total water transportation cost (original water cost per ton) and total cost for the movement via the next least costly non-system alternative means of shipment (i.e., land cost per ton or alternate water cost per ton) was made. This difference is referred to as the net cost savings of the ton's potential movement via the system. These savings are deemed net as opposed to gross because the water costs are inclusive of system lock delays. Savings measured with lock delays taken out of water costs are referred to as gross cost savings. Table 4 - 3 shows the overall distribution of net gross cost savings for the entire system of movements. Table 4 - 4 shows the distribution of these net cost savings broken down by the different levels of matching. As can be seen, 25 records of the total number of records for the system, has a negative net cost savings. This means that for these movements, using a non-system alternative means of transportation appears to be the least costly, suggesting that some shippers are behaving uneconomically. Those movements in the TVA sample with a negative net cost savings were only included in the first level of matching. For all subsequent levels of matching, the effect of the negative net cost savings sample movements were excluded from the calculation and assignment of weighted costs. These movements were excluded in order to minimize the distortions that the negative net cost savings movements produced in the subsequent levels of matching.

As a final illustration of the transportation rate analysis sample and the expansion of this sample to the population of movements, table 4 - 5 displays the weighted average net cost savings and weighted average mileage, for the system as a whole by commodity group.

Table 4 - 3

Net Cost Savings Distribution
For the Total System of Movements
(Fy 97 Prices)

Net Cost Savings ($)	# of Records	Tons	% of Total Tons
<0	127	1,069,031	1%
>=0 <1.50	153	6,523,431	8%
>=1.50 <4.00	592	6,977,977	9%
>=4.00 <7.00	1,919	18,034,700	22%
>=7.00 <11.00	1,892	20,317,128	25%
>=11.00 <16.00	1,552	13,876,797	17%
>=16.00 <24.00	1,041	11,353,009	14%
>=24.00 <31.00	399	1,596,202	2%
>=31.00 <36.00	186	546,472	1%
>=36.00 <42.00	132	372,537	0.5%
>=42.00 <50.00	58	337,460	0.4%
>=50.00 <60.00	9	46,001	0.1%
>=60.00 <70.00	11	28,540	0.04%
>=70.00 <80.00	8	21,445	0.03%
>=80.00	2	4,122	0.01%
Total	8,081	81,104,852	100%

Table 4 - 4

Net Cost Savings Distribution by Levels of Matching
For the Total System of Movements

First Level of Matching

Net Cost Savings ($)	# of Records	Tons	% of Total Tons
<0	25	909,843	3%
>=0 <1.50	29	4,703,915	13%
>=1.50 <4.00	86	4,467,408	13%
>=4.00 <7.00	302	9,053,889	26%
>=7.00 <11.00	198	7,029,690	20%
>=11.00 <16.00	196	5,456,140	15%
>=16.00 <24.00	95	3,462,552	10%
>=24.00 <31.00	12	172,081	0%
>=31.00 <36.00	2	18,647	0%
>=36.00 <42.00	2	12,594	0%
>=42.00 <50.00	2	102,238	0%
>=50.00 <60.00	1	20,646	0%
>=60.00 <70.00	0	0	0%
>=70.00 <80.00	0	0	0%
>=80.00	0	0	0%
Total	950.00	35,409,643	100%

Second Level of Matching

Net Cost Savings ($)	# of Records	Tons	% of Total Tons
<0	0	0	0%
>=0 <1.50	83	1,730,255	5%
>=1.50 <4.00	335	2,069,308	5%
>=4.00 <7.00	1245	8,228,273	21%
>=7.00 <11.00	1120	11,580,462	30%
>=11.00 <16.00	931	7,408,079	19%
>=16.00 <24.00	421	6,639,167	17%
>=24.00 <31.00	46	547,193	1%
>=31.00 <36.00	12	96,827	0%
>=36.00 <42.00	6	25,263	0%
>=42.00 <50.00	10	111,616	0%
>=50.00 <60.00	0	0	0%
>=60.00 <70.00	0	0	0%
>=70.00 <80.00	0	0	0%
>=80.00	0	0	0%
Total	4,209.00	38,436,443	100%

Table 4 - 4 (cont.)

Net Cost Savings Distribution by Levels of Matching
For the Total System of Movements

Third Level of Matching

Net Cost Savings ($)	# of Records	Tons	% of Total Tons
<0	55	83,016	2%
>=0 <1.50	27	50,411	1%
>=1.50 <4.00	89	282,920	6%
>=4.00 <7.00	213	376,313	9%
>=7.00 <11.00	405	1,263,864	29%
>=11.00 <16.00	250	623,404	14%
>=16.00 <24.00	282	680,632	15%
>=24.00 <31.00	180	473,277	11%
>=31.00 <36.00	90	250,459	6%
>=36.00 <42.00	62	181,443	4%
>=42.00 <50.00	29	87,789	2%
>=50.00 <60.00	3	13,349	0%
>=60.00 <70.00	11	28,540	1%
>=70.00 <80.00	7	20,645	0%
>=80.00	2	4,122	0%
Total	1,705.00	4,420,184	100%

Fourth Level of Matching

Net Cost Savings ($)	# of Records	Tons	% of Total Tons
<0	40	42,714	2%
>=0 <1.50	6	18,343	1%
>=1.50 <4.00	59	116,042	5%
>=4.00 <7.00	132	315,482	14%
>=7.00 <11.00	145	398,251	18%
>=11.00 <16.00	141	294,667	13%
>=16.00 <24.00	184	451,814	20%
>=24.00 <31.00	128	334,159	15%
>=31.00 <36.00	68	132,942	6%
>=36.00 <42.00	41	111,074	5%
>=42.00 <50.00	17	35,817	2%
>=50.00 <60.00	5	12,006	1%
>=60.00 <70.00	0	0	0%
>=70.00 <80.00	1	800	0%
>=80.00	0	0	0%
Total	967.00	2,264,111	100%

Table 4 - 4 (cont.)

Net Cost Savings Distribution by Levels of Matching
For the Total System of Movements

Fifth Level of Matching

Net Cost Savings ($)	# of Records	Tons	% of Total Tons
<0	7	33,458	6%
>=0 <1.50	8	20,507	4%
>=1.50 <4.00	23	42,299	7%
>=4.00 <7.00	27	60,743	11%
>=7.00 <11.00	24	44,861	8%
>=11.00 <16.00	34	94,507	16%
>=16.00 <24.00	59	118,844	21%
>=24.00 <31.00	33	69,492	12%
>=31.00 <36.00	14	47,597	8%
>=36.00 <42.00	21	42,163	7%
>=42.00 <50.00	0	0	0%
>=50.00 <60.00	0	0	0%
>=60.00 <70.00	0	0	0%
>=70.00 <80.00	0	0	0%
>=80.00	0	0	0%
Total	250.00	574,471	100%

Table 4 - 5

Net Cost Savings & Mileage
By Commodity Group
Total System
(Fy 1997 Prices)

Commodity Group	Weighted Net Cost Savings ($)	Weighted Mileage
Farm Products	9.68	479
Metallic Ores	8.81	1,208
Coal	1.76	1,243
Crude Petroleum	12.86	219
Non-Metallic Minerals	10.85	1,013
Forest Products	7.30	885
Industrial Chemicals	10.83	921
Agricultural Chemicals	11.12	808
Petroleum Products	9.85	496
All Others	7.80	598